

FINAL SUBMITTAL

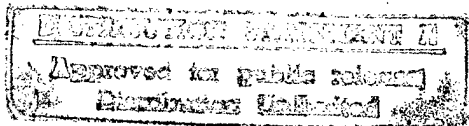
ENERGY SAVINGS OPPORTUNITY STUDY

**FORT SAM HOUSTON, TEXAS
FY-86**

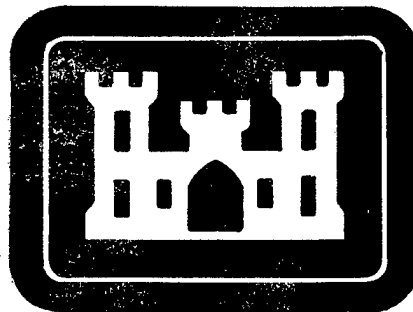
DACA63-86-C-0121

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

VOLUME 1 EXECUTIVE SUMMARY



PREPARED FOR



**FORT WORTH DISTRICT
U. S. ARMY CORPS OF ENGINEERS**

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MAY 26, 1988




DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

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ENERGY SAVINGS OPPORTUNITY SURVEY (ESOS)
FORT SAM HOUSTON, TEXAS
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These forms were included in final form in
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EXECUTIVE SUMMARY

0. OVERVIEW

This report documents an analysis of selected ECO's applied to selected buildings and areas at Fort Sam Houston and Camp Bullis. Based on this analysis, recommended ECO's were packaged into proposed projects. Implementation documentation for the recommended projects was prepared and was included in this study. A more detailed summary of the study begins on page 1-1 of the executive summary.

A. STUDY PERIOD

This study was begun on September 10, 1986 and is now completed with this (Final) submittal dated May 26, 1988.

The analysis and proposed projects documented in this study were based on field surveys which took place between our entry interview with base personnel on October 6, 1986 and our exit interview on March 18, 1987.

B. RECOMMENDED ECO's AND RESULTANT SAVINGS

Recommended ECO's were grouped into 7 separate recommended projects with a total estimated cost of \$753,928 and a total estimated annual energy and dollar savings of 11,890 MBTU and \$202,017 respectively. The projects have an average simple payback of 5.0 years. Recommended projects are summarized below:

RECOMMENDED PROJECTS

PROJECT	CONSTRUCTION COST* (FUNDING)	GAS SAVINGS (MBTU/YR)	ELEC. SAVINGS (MBTU/YR)	ANNUAL DOLLAR SAVINGS	SIR	SIMPLE PAYBACK
1. MORE EFFICIENT AREA LTG (ECIP)	\$369,969 (ECIP)	0	5,094	\$138,508	4.9	2.6
2. REDUCE LTG LEVELS & ADD LTG CONTROLS, BLDGS 4196 & 4197	\$40,879 (OMA)	0	592	\$11,370	4.4	3.0
3. ATTIC INSULATION, BULLIS	\$493 (OMA)	6**	5	\$134	4.2	3.7
4. PREVENT STRATIFICATION	\$92,186 (OMA)	3,541	-53	\$13,841	3.2	6.7
5. ATTIC INSULATION, FSH	\$29,778 (OMA)	218	272	\$6,088	2.9	4.9
6. WINDOW IMPROVEMENTS	\$109,215 (OMA)	673	587	\$13,936	1.9	7.8
7. EMCS EXTENSION	\$111,408 (OMA)	211	744	\$18,140	1.6	6.2
TOTALS	\$753,928	4,643 6**	7,241	\$202,017	-	-
TOTAL ENERGY SAVINGS 11,890 MBTU/YR.						

* LINE 1A of LCCA

** LPG

C. ECO's NOT RECOMMENDED

Twelve of the ECO's investigated were either not recommended at all or were not recommended for selected buildings or areas. These are summarized below:

ECO'S NOT RECOMMENDED

<u>ECO DESCRIPTION</u>	<u>COMMENTS</u>
1. SEPARATE DOMESTIC FROM SPACE HEAT WATER BOILERS	ALREADY ACCOMPLISHED, OR DHW IS NOT JUSTIFIED
2. RECLAIM A/C REJECTED HEAT FOR DHW	MANY BLDGS. HAVE NO A/C. FOR OTHERS, SIR $\frac{1}{4}$ 1.
3. ADD WALL INSULATION	SIR'S $\frac{1}{4}$ 1.
4. MODIFY WINDOWS, BLDGS. 1111, 1150	WINDOW MODIFICATIONS WOULD NOT AFFECT ENERGY SAVINGS IN CONDITIONED PORTION OF BUILDING. RECOMMENDED FOR 19 OTHER BUILDINGS.
5. ADD ENTRY VESTIBULES	SIR'S $\frac{1}{4}$ 1.
6. ADD ATTIC INSULATION, BLDGS. 1111, 1150	SIR'S $\frac{1}{4}$ 1. RECOMMENDED FOR 17 OTHER BUILDINGS.
7. EXTEND EMCS TO BLDG. 4188	SIR $\frac{1}{4}$ 1. RECOMMENDED FOR FOUR OTHER BUILDINGS.
8. INSULATE DHW TANKS, CAMP BULLIS	THESE BUILDINGS UNDERGOING RENOVATION.
9. REDUCE AIR INFILTRATION, CAMP BULLIS	THESE BUILDINGS UNDERGOING RENOVATION, OR ALREADY ACCOMPLISHED.
10. ADD ATTIC INSULATION, CAMP BULLIS	THESE BUILDINGS UNDERGOING RENOVATION.
11. ADD INSULATING WINDOWS, CAMP BULLIS	THESE BUILDINGS UNDERGOING RENOVATION.
12. MORE EFFICIENT STREET AND AREA LIGHTING	THOSE ECO'S WITH SIR $\frac{1}{4}$ 1 OR WHICH CAN BE REPLACED WITH A MORE COST EFFECTIVE ECO ARE NOT RECOMMENDED.

D. COORDINATION OF RECOMMENDED PROJECTS WITH ONGOING WORK

Because of ongoing changes at FSH, projects recommended in this study, which was based on survey data collected over a set period of time, will need to be coordinated with field conditions and programmed projects at the time of design and implementation. Although it is not our intent to update the study for changes in conditions which took place or are planned for implementation after the compilation of our field survey, we have included a list of changes in conditions, programmed work, and potential changes which have been brought to our attention.

CHANGED FIELD CONDITIONS

<u>Tab. No. of ECO Effected</u>	<u>Field Change</u>
E1.2	Building nos. 8, 13, 621 and 633 are now equipped with central HVAC units.
E1.11	Installation of attic insulation in buildings 6201, 6202, 6203 and 6204 was completed on 18 Dec., 1987.

PROGRAMMED PROJECTS AND POTENTIAL CHANGES

<u>Tab No. of ECO Effected</u>	<u>Project. No.</u>	<u>Project Name</u>	<u>Comments</u>
E1.3, E1.4, E1.6	9153200	Universal Training Facility	Will demolish bldgs. in the 1100 area after FY 1995
E1.6	0120000	Attic Insulation	Will add attic insulation to bldgs. in the 1400 area, FY 91
E1.7, E1.8	9164880	Information Systems Facility	Will demolish one bay of bldg. 4190, FY 91.
E1.7	-	-	Will move medical storage from bldg. 2640. This bldg. would then be used for AHS storage.
E2.32, E2.33, E2.34	-	-	It is our understanding that SARPMA will be shut down in Sep., 1989.

E. RECOMMENDATIONS FOR FURTHER INVESTIGATION BEYOND THE SCOPE OF THIS STUDY

1. Meter readings for natural gas consumption at buildings in the 1100 and 1400 areas were excessively high suggesting that heating systems may not be shut off at night and on weekends. The practicality of adding on-off and/or night setback for HVAC systems in these and similar buildings should be investigated.
2. The scope of work for this study addressed a very limited set of buildings. ECO's which were recommended for implementation in this study should be investigated for other buildings which were not included in the scope.
3. The practicality of adding ceiling insulation in building 910 should be investigated.

DETAILED EXECUTIVE SUMMARY

1. Introduction

This report presents the Final Submittal of the Energy Savings Opportunity Survey (ESOS) for Fort Sam Houston, Texas. It is prepared under Contract No. DACA63-86-C-0121, between the U.S. Army Engineer District, Fort Worth, Corps of Engineers, and The Benham Group. The work accomplished under this project is part of the Department of the Army Energy Engineering Analysis Program (EEAP).

This report illustrates the results of the work that has been accomplished. This work includes: (1) the review of previous studies, (2) re-evaluation of selected projects, (3) evaluation of selected energy conservation opportunities (ECO's), and (4) limited site surveys to evaluate selected buildings and areas. Included in the appendix of this report is the analysis of each ECO studied, the completed implementation documents with their supporting data, and the results of building computer simulations.

Unless indicated otherwise, all buildings and areas addressed in this study are at Fort Sam Houston, Texas. Some of the buildings addressed in this study (P-6201, P-6202, P-6203, P-6204, and P-6215) are located at Camp Bullis. Camp Bullis is not contiguous with Fort Sam Houston and is located approximately 18 miles northwest of Ft. Sam Houston.

2. Building Data

(Current at the time of the field survey. See paragraph 0, D)

The following buildings and areas were surveyed. Building data pertinent to the analysis of these buildings is as follows:

- A. Exterior street and area lighting, basewide, at FSH was surveyed to reevaluate a 1984 EEAP. The study was expanded into the 4100 area (formerly Kelly Air Force Base Annex). No buildings or building data is included.
- B. Designated buildings were surveyed to reevaluate a 1984 EEAP for separating domestic hot water boilers from space heat boilers. The buildings included Building Numbers 250, 330, 902, 904, 905, 906, 907, 920, 924, 925, 926, 1000, 1001, 1377, 2256, 2269, 2376, 2397, 2399, 2789, 2791, 2901, and 4011. Of these buildings, only 2256 was viable for this ECO; domestic hot water systems were appropriately separated from space heat systems in all the other buildings surveyed. Interim submittal review identified Building 2256, a latrine with discontinued shower facilities, as currently being classified as an administrative toilet room. As such, domestic hot water is not authorized, obligating shut-down of that system and deletion of Building 2256 from this study. No building or system data is pertinent or included.
- C. The following 22 residential units were surveyed to evaluate the advisability of using rejected heat from air conditioning to preheat domestic hot water.

<u>BLDG NO.</u>	<u>AC UNIT</u>
8	None
13	None
106	None
113	None
165	None
177	None
412	1 4-1/2-ton
443	2 2-1/2-ton
551	2 2-1/2-ton
621	None
633	None
674	1 4-1/2-ton/1 3-1/2 ton (duplex dwelling unit)
680	2 3-1/2-ton (duplex dwelling unit)
770	1 3-1/2-ton
780	1 3-1/2-ton
863	1 3-1/2-ton
8019	2 2-ton (duplex dwelling unit)
8150	2 2-1/2-ton (duplex dwelling unit)
8270	2 2-ton (duplex dwelling unit)
9227	2 2-1/2-ton (duplex dwelling unit)
9320	1 5-ton (duplex dwelling unit)
9509	2 2-1/2-ton (duplex dwelling unit)

D. The following 21 buildings were surveyed to analyze the advisability of adding insulation to the walls. The 21 buildings were also surveyed to analyze the advisability of adding roof insulation, and replacing windows or applying low-E film to existing or replaced windows.

<u>BLDG. NO.</u>	<u>PRIMARY USE OF BUILDING</u>	<u>BLDG. TYPE</u>	<u>BLDG. AREA</u>	<u>WINDOWS</u>	<u>COMMENTS</u>
1111	Medical supply and storage	Pre-engineered metal	8,434 s.f.	Single panel with exterior solar screens	Only work-room air conditioned
1150	Classrooms/ Office	Pre-engineered metal	8,434 s.f.	Single pane, venetian blinds inside	Only office area air conditioned
1152	Office	CMU	5,168 s.f.	Single pane, venetian blinds inside	
1153	Office	CMU	5,168 s.f.	Single pane, venetian blinds inside	
1155	Classrooms	Pre-engineered metal	2,100 s.f.	Single pane, venetian blinds inside	

<u>BLDG. NO.</u>	<u>PRIMARY USE OF BUILDING</u>	<u>BLDG. TYPE</u>	<u>BLDG. AREA</u>	<u>WINDOWS</u>	<u>COMMENTS</u>
1154	Barracks (unoccupied)	CMU	5,168 s.f.	Single pane, lower 75% painted white	
1158	Barracks (unoccupied)	CMU	5,168 s.f.	Single pane, lower 75% painted white	
1159	Barracks (unoccupied)	CMU	5,168 s.f.	Single pane, lower 75% painted white	
1160	Barracks (unoccupied)	CMU	5,168 s.f.	Single pane, lower 75% painted white	
1161	Barracks (unoccupied)	CMU	5,168 s.f.	Single pane, lower 75% painted white	
1440	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1441	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1442	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1443	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1444	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	

<u>BLDG. NO.</u>	<u>PRIMARY USE OF BUILDING</u>	<u>BLDG. TYPE</u>	<u>BLDG. AREA</u>	<u>WINDOWS</u>	<u>COMMENTS</u>
1445	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	Single pane, venetian blinds, curtains, or combinations of these	
1446	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1447	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1448	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1449	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	
1450	Office/ Storage/ Classrooms	Pre-engineered metal	4,200 s.f.	+Single pane, venetian blinds, curtains, or combinations of these	

+ Venetian blinds in poor condition shading coefficient not used.

E. Building 2376 was surveyed to analyze the advisability of adding an entry vestibule. This building is representative of buildings

2791 Barracks
2972 Administration
2376 Hospital/Clinic
2264 Barracks
2265 Barracks/Dining Facility
2266 Barracks

This building was selected for analysis because it is the building in this group with the most in and out foot traffic.

- F. Designated buildings were surveyed to analyze the advisability of adding loading dock door seals. Building Numbers 2640, 4188, 4189, 4190, 4191, 4192, 4193, 4194, 4195, 4196 and 4197 were included. Typically, building walls and the doors to these warehouse buildings exist and open onto a truck-height dock. The dock width is 16 feet, minimum.
- G. Building 2640 was surveyed to analyze the advisability of adding fans to prevent air stratification. This building is representative of the following 11 warehouse types:

<u>BLDG NO.</u>	<u>PRIMARY USE OF BLDG. & AREA</u>	<u>OTHER AREA</u>
2640	Medical Storage, 38,482 s.f.	-
4188	Warehouse, 86,000 s.f.	Office, 800 s.f.
4189	Warehouse, 86,800 s.f.	-
4190	Warehouse, 68,600 s.f.	Office, 18,200 sf
4191	Warehouse, 86,800 s.f.	-
4192	Warehouse, 86,800 s.f.	-
4193	Warehouse, 86,800 s.f.	-
4194	Warehouse, 123,200 s.f.	-
4195	Warehouse, 119,130 s.f.	Office, 4,070 sf
4196	Warehouse, 89,180 s.f.	Office, 38,200 sf
4197	Warehouse, 101,900 s.f.	Office, 25,500 sf

- H. The buildings on the above list, excluding Building No. 2640, were surveyed to analyze the advisability of adding monitor and control functions for the buildings to an existing FSH EMCS System.
- I. The following buildings at Camp Bullis were surveyed to analyze the advisability of insulating DHW tanks, reducing air infiltration, adding attic insulation, and adding interior insulation to windows.

<u>BLDG. NO.</u>	<u>PRIMARY FUNCTION OF BLDG.</u>	<u>GROSS AREA</u>
P-6201	Family Housing	2400 S.F.
P-6202	Family Housing	1600 S.F.
P-6203	Family Housing	1850 S.F.
P-6204	Family Housing	6204 S.F.
P-6215	Hunting Lodge/Office	900 S.F. Office/ 3000 S.F. Lodge

3. Present Energy Consumption (FY 87)

- A. Total Annual Energy Used: 1,009,853 MBTU/YR, for FY1987. Fort Sam Houston is accountable for energy useage at two detached facilities; this total does not include those detached facilities, (Camp Bullis and Canyon Lake).

B. Source Energy Consumption:

<u>TYPE</u>	<u>UNITS</u>	<u>COST</u>	<u>MBTU</u>
Electricity	144,872,954 KWH	\$8,515,239	494,451
Fuel Oil	4,900 GALS	\$3,675	676
Natural Gas	5,145,176 THERMS	\$1,783,804	514,518
LPG	2,190 GALS	\$1,932	208

C. Energy consumption of the buildings and areas for which energy saving projects were recommended in this study comprise 28% of the total FSH, energy consumption. This information is shown graphically in Table ES-5.

4. Historical Energy Consumption (FY 86)

Total annual energy used: 950,244 MBTU/yr, for FY 1986. Does not include Camp Bullis or Canyon Lake.

5. Reevaluated Project's Results

<u>Title</u>	<u>Tab.No. in Study</u>	<u>Simple Payback (year)</u>	<u>SIR</u>
Conversion to High Pressure Sodium Street Lighting (ECIP)	<u>E2.18</u>	<u>6.5</u>	<u>1.9</u>
Replace 361 300-watt Incandescent Street lamp bulbs with 143-watt energy-conserving Bulbs	Project described under Tab E.2.18 above, recommended in lieu of this project.		
Replace 140 400-watt Mercury Lamps with 360-Watt High-pressure Sodium Lamps (No Ballast Change Required)	<u>E2.27</u>	<u>9.9</u>	<u>1.54</u>
	Project described under Tab E2.26 is recommended in lieu of this project.		
Recommended alternative:	<u>E2.26</u>	<u>2.4</u>	<u>5.5</u>
Replace 142 175-watt Mercury Tubes with 150-watt high-pressure Sodium Tubes (No ballast change required)	<u>E2.31</u>	<u>-20.12</u>	<u>-.34</u>
Replace 142 175-watt Mercury Tubes with 100-watt high-pressure Sodium Tubes and Ballasts	<u>E2.30</u>	<u>9.6</u>	<u>1.4</u>
Separation of Domestic Hot Water Boilers from Space Heat Boilers	Work already accomplished or DHW to be shut off		

6. Energy Conservation Analysis

A. ECO's Investigated

See Table ES1.

B. ECO's Recommended

See Table ES2.

C. ECO's Rejected

See Table ES3.

D. ECIP Projects Developed

The ECO's recommended for more efficient street and area lighting comprise the only logical grouping of related ECO's which qualify for ECIP funding.

PROJECT DATA:

Cost (construction cost + SIOH): \$390,355

Annual Energy Savings: 5094 MBTU (electricity)

Annual Dollar Savings: \$138,508

SIR: 4.92

Simple Payback 2.6

Analysis Date: Jan. 1988

Year Programmed: 1991

Programmed Year Cost: \$439,930

ECO's included in this project:

Tab. No. in Study	Simple Payback (years)	SIR
E2.1	1.3	9.7
E2.2	2.2	5.8
E2.3	1.5	8.6
E2.5	2.8	4.5

E2.6	2.6	4.9
E2.9	3.6	3.5
E2.10	1.6	7.9
E2.11	3.5	3.5
E2.13	3.3	3.6
E2.15	1.2	9.8
E2.17	.5	22.5
E2.18	6.5	1.9
E2.19	4.5	2.8
E2.23	2.9	4.7
E2.24	5.8	2.3
E2.26	2.4	5.5
E2.28	6.0	2.3
E2.30	9.6	1.4

E. Other Energy Conservation Projects Developed

1. Interior Electrical Package. ECO's to implement more efficient interior lighting have been grouped in an OMA project as follows:

Cost (construction cost + SIOH): \$43,127

Annual Energy Savings: 592 MBTU (electricity)

Annual Dollar Savings: \$11,370

SIR: 4.38

Simple Payback: 3.04 years

Analysis Date: Jan 1988

Year Programmed: 1988

Programmed Year Cost: \$43,127

ECO's included in this project:

Tab No. in Study	Simple Payback (years)	SIR
E2.33	3.1	4.3
E2.34	2.9	4.6

2. Windows in 1100 and 1440 areas. ECO to implement more efficient and/or solar, window glazings.

This ECO is proposed as an OMA project.

Cost (construction cost + SIOH): \$115,222

Annual Energy Savings: 1260 MBTU (electricity 587, natural gas 673)

Annual Dollar Savings: \$13,936

Simple Payback: 7.77 years

SIR: 1.90

Analysis Date: Jan 1988

Year Programmed: 1988

Programmed Year Cost: 115,222

ECO included in this project:

Tab No. in Study	Simple Payback (years)	SIR
E1.4	7.77	1.90

3. Add attic insulation in 1100 and 1400 areas. ECO to implement adding attic insulation to poorly insulated attics. This ECO is proposed as an OMA project.

Cost (construction cost + SIOH): \$31,426

Annual Energy Savings: 490 MBTU (Electricity 272, natural gas 218)

Annual Dollar Savings: \$6,088

Simple Payback: 4.91 years

SIR: 2.94

Analysis Date: Jan 1988

Year Programmed: 1988

Programmed Year Cost: \$30,713

ECO's included in this project:

Tab No. in Study	Simple Payback (years)	SIR
E1.6	4.91	2.94

4. Add ceiling fans to prevent air stratification in building 2640 and 4100 area. This ECO is proposed as a OMA project.

Cost (construction cost + SIOH): \$97,256

Annual Energy Savings: 3488 MBTU (electricity -53, natural gas 3541)

Annual Dollar Savings: \$13,841

Simple Payback: 6.68 years

SIR: 3.16

Analysis Date: Jan 1988

Year Programmed: 1988

Programmed Year Cost: \$97,256

ECO's included in this project:

Tab No. in Study	Simple Payback (years)
E1.7	6.68

5. Extend existing EMCS to serve buildings 4190, 4195, 4196, 4197. This ECO is proposed as an OMA project.

Cost (construction cost + SIOH): \$117,535

Annual Energy Savings: 955 MBTU (electricity 744, natural gas 211)

Annual Dollar Savings: \$18,140

Simple Payback: 6.17 years

SIR: 1.62

Analysis Date: Jan 1988

Year Programmed: 1988

Programmed Year Cost: \$117,535

ECO's included in this project:

Tab No. in Study	Simple Payback (years)	SIR
E1.8	6.17	1.62

6. Add attic insulation to building P-6215, Camp Bullis. This ECO is proposed as an OMA project.

Cost (construction cost + SIOH): \$520

Annual Energy Savings: 11 MBTU (electricity 5, LPG 6)

Annual Dollar Savings: \$134

Simple Payback: 3.69 years

SIR: 4.23

Analysis Date: Jan 1988

Year Programmed: 1988

Programmed Year Cost: \$520

ECO's included in this project:

Tab No. in Study	Simple Payback (years)	SIR
E1.11	3.69	4.23

- F. Operational of Policy Change Recommendations: Buildings 2256 and 2269 contain operational domestic hot water systems that are either not required or no longer authorized; shut-down of these two systems is recommended.

7. Energy and Cost Savings

- A. Total Potential Energy and Cost Savings: 11,890 MBTU/YR, \$202,017/YR
- B. Percentage of Energy Conserved: 1.177% of FSH 1987 total energy consumption

- C. Energy Use and Cost Before and After Energy Conservation Opportunities are Implemented are estimated as follows:

ENERGY USE AND COST BEFORE AND AFTER IMPLEMENTATION OF RECOMMENDED PROJECTS

	Energy before implement- ation (FY87) (MBTU/YR)	Estimated energy savings (MBTU/YR)	Estimated energy after implement- ation (MBTU/YR)	Cost before implement- ation (FY 87) (\$/YR) *	Estimated Cost Savings (\$/YR)**	Estimated cost after implement- ation (\$/YR)
Electricity	494,451	7,241	487,210	8,994,064	131,714	8,862,350
Fuel Oil	676	0	676	3,675	0	3,675
Natural Gas	514,518	4,643	509,875	2,150,685	19,408	2,131,277
LPG	208	6	208	1,423	41	1,382
Total	1,009,853	11,890	997,967	11,149,847	151,163	10,998,684

* Cost shown for electricity, LPG and natural gas is based on the energy rates in appendix H. Costs for fuel oil are actual costs provided by DEH.

** Shows energy cost savings only.

Estimated energy savings compared to total FSH energy usage is shown graphically in Table ES-6.

8. Energy Plan

A. Project Breakouts and schedule of Energy Conservation Project implementation

All parts of all recommended projects should be implemented as soon as possible in order to take advantage of the rapid paybacks which can be achieved. Table ES-4 lists recommended projects and ECO's within projects in order of descending SIR.

Table ES-1
ECO's Investigated

The tab no. of recommended ECO's is shown in bold type. The building numbers for which that ECO is recommended are shown in bold type.

TAB NO. IN STUDY	BUILDINGS INVOLVED	ECO DESCRIPTION	COMMENTS
E1.1	250, 330, 904, 905, 906, 920, 925, 1000, 1001 1377, 2256, 2269, 2376, 2399, 2789, 2901, 4011	Separate domestic hot water boilers from space heat boilers	
E1.2	8, 13, 106, 113, 165, 177, 412, 443, 551, 621, 633, 674, 680, 770, 780, 863, 8019, 8150, 8270, 9227, 9320, 9509	Reclaim rejected heat from air conditioning to preheat domestic hot water	
E1.3	1111, 1150, 1152, 1153, 1154, 1155, 1158, 1159, 1160, 1161, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1450	Add exterior (wall) insulation	
E1.4	1111, 1150, 1152, 1153, 1154, 1155, 1158, 1159, 1160, 1161, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1450	Windows	
E1.5	2791, 2792, 2376, 2264, 2265, 2266	Add entry vestibules	
E1.6	1111, 1150, 1152, 1153, 1154, 1155, 1158, 1159, 1160, 1161, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1148, 1149	Add attic insulation	

TAB NO. IN STUDY	BUILDINGS INVOLVED	ECO DESCRIPTION	COMMENTS
E1.7	2640, 4188, 4189, 4190, 4191, 4192, 4193, 4194, 4195, 4196, 4197	Add ceiling fans to prevent air stratification	
E1.8	4188, 4190, 4195, 4196, 4197	Extend existing EMCS to serve these additional buildings	
E1.9	P-6201, P-6202, P-6203, P-6204, P-6215	Insulate domestic hot water tanks	
E1.10	P-6201, P-6202, P-6203 P-6204, P-6215	Reduce air infiltration	
E1.11	P-6201, P-6202, P-6203 P-6204, P-6215	Add attic insulation (Camp Bullis)	
E1.12	P-6201, P-6202, P-6203 P-6204	Add interior insulating windows	
	Ft. Sam Houston Basewide	Convert to more efficient street and area lighting. See individual lighting ECO descriptions below.	
E2.1	Replace 1500W Incandescent Lighting at Football/Softball Field with HPS		
E2.2	Replace 1500 W Incandescent Lighting at Recreational Areas with HPS		
E2.3	Replace 1500 W Incandescent Area Lighting throughout FSH		
E2.4	Replace 1500W Incandescent Lighting at Recreational Areas with HPS		
E2.5	Replace 750W Incandescent Lighting at Recreational Areas with HPS		
E2.6	Replace 750W Incandescent Area Lighting throughout FSH		
E2.7	Replace 750W Incandescent Area Lighting throughout FSH		
E2.8	Replace 750W Incandescent Area Lighting @ 4200 Bldgs.		
E2.9	Replace 500W Incandescent Area Lighting throughout FSH		

- E2.10 Replace 300W Incandescent Area
Lighting @ Heliport
- E2.11 Replace 300W Incandescent
Area Lighting throughout FSH
- E2.12 Replace 300W Incandescent
Area Lighting at Park
- E2.13 Replace 150W Incandescent
Area Lighting throughout FSH
- E2.14 Replace 150W Incandescent Area
Lighting at SARPMA buildings
- E2.15 Replace 100W Incandescent
Area Lighting throughout FSH
- E2.16 Replace 100W Incandescent Area
Lighting at Park & Recreational Areas
- E2.17 Replace 60W, 230V Incandescent
Lamps with 9W Fluorescent
- E2.18 Replace 2500 Lumen Incandescent
Lamps with 50-Watt HPS
- E2.19 Replace 500W Quartz
Area Lighting throughout FSH
- E2.20 Replace 500W Quartz
Area Lighting at Riding Stables
- E2.21 Replace 500W Quartz
Area Lighting at SARPMA buildings
- E2.22 Replace 300W Quartz Area
Lighting at Jadwin Road
- E2.23 Replace or Relamp & Ballast
1000W Mercury Vapor Fixtures
- E2.24 Replace 700W Mercury Vapor Area
Lighting w/310W HPS
- E2.25 Retrofit 700W Mercury Vapor Area
Lighting w/310W HPS
- E2.26 Replace 400W Mercury Lamps with
150W HPS
- E2.27 Relamp 400W Mercury Lamps with
360W HPS
- E2.28 Convert 250W Mercury Vapor Area
Lighting to 150W HPS
- E2.29 Replace 250W Mercury Vapor Lamps
with 215W HPS Lamps, No Ballast Change
- E2.30 Replace 175W Mercury Vapor Lamps
with 100W HPS Lamps & Ballast
- E2.31 Replace 175W Mercury Vapor Lamps
with 150W HPS Lamps, No Ballast Change
- E2.32 Reduce Footcandles in Buildings
4196 and 4197 by Installing Thrift/Mate Lamps
- E2.33 Reduce Footcandles in Buildings
4196 and 4197 by Removing Light Fixtures
- E2.34 Add Occupancy Detector
Controls for Office Lighting in Buildings 4196 and 4197

Table ES-2
ECO's Recommended

TAB NO. IN STUDY	BUILDINGS FOR WHICH ECO IS RECOMMENDED	ECO DESCRIPTION
E1.4	1152, 1153, 1154, 1155, 1158, 1159, 1160, 1161, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1450	Windows
E1.6	1152, 1153, 1154, 1155, 1158, 1159, 1160, 1161, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1450	Add attic insulation
E1.7	2640, 4188, 4189, 4190, 4191, 4192, 4193, 4194, 4195, 4196, 4197	Add ceiling fans to prevent air stratification
E1.8	4190, 4195, 4196, 4197	Extend existing EMCS to serve these additional buildings
E1.11	P-6215	Add attic insulation (Camp Bullis)
E2.1	Replace 1500W Incandescent Lighting at Football/Softball Field with HPS	
E2.2	Replace 1500 W Incandescent Lighting at Recreational Areas with HPS	
E2.3	Replace 1500 W Incandescent Area Lighting throughout FSH	
E2.5	Replace 750W Incandescent Lighting at Recreational Areas with HPS	
E2.6	Replace 750W Incandescent Area Lighting throughout FSH	
E2.9	Replace 500W Incandescent Area Lighting throughout FSH	
E2.10	Replace 300W Incandescent Area Lighting @ Heliport Base	
E2.11	Replace 300W Incandescent Area Lighting throughout FSH	
E2.13	Replace 150W Incandescent Area Lighting throughout FSH	

- E2.15 Replace 100W Incandescent
Area Lighting throughout FSH
- E2.17 Replace 60W, 230V Incandescent
Lamps with 9W Fluorescent
- E2.18 Replace 2500 Lumen Incandescent
Lamps with 50-Watt HPS
- E2.19 Replace 500W Quartz
Area Lighting throughout FSH
- E2.23 Replace or Relamp & Ballast
1000W Mercury Vapor Fixtures
- E2.24 Replace 700W Mercury Vapor Area
Lighting w/310W HPS
- E2.26 Replace 400W Mercury Lamps with
150W HPS
- E2.28 Convert 250W Mercury Vapor area lighting to 150W HPS
- E2.30 Replace 175W Mercury Vapor Lamps
with 100W HPS Lamps & Ballast
- E2.33 Reduce Footcandles in Buildings
4196 and 4197 by Removing Light Fixtures
- E2.34 Add Occupancy Detector
Controls for Office Lighting in Buildings 4196 and 4197

Table ES-3
ECO's Not Recommended

TAB NO. IN STUDY	BUILDINGS FOR WHICH ECO IS NOT RECOMMENDED	ECO DESCRIPTION	REASON FOR REJECTION
E1.1	250, 330, 904, 905, 906, 920, 925, 1000, 1001, 1377, 2256, 2269, 2376, 2399, 2789, 2901, 4011	Separate domestic hot water boilers from space heat boilers	This has al- ready been done in all bldgs. except 2269 and 2256. DHW is not required in these bldgs.
E1.2	8, 13, 106, 113, 165, 177, 412, 443, 551, 621, 633, 674, 680, 770, 780, 863, 8019, 8150, 8270, 9227, 9320, 9509	Reclaim rejected heat from air conditioning to preheat domestic hot water	Many bldgs. have no A/C. For remaining bldgs., SIR's are all less than 1.
E1.3	1111, 1150, 1152, 1153, 1154, 1155, 1158, 1159, 1160, 1161, 1440, 1441, 1442, 1443, 1444, 1445, 1446, 1447, 1448, 1449, 1450	Add exterior (wall) insulation	SIR's are all less than 1.
E1.4	1111, 1150	Windows	SIR's are less than 1, or ECO did not apply
E1.5	2791, 2792, 2376, 2264, 2265, 2266	Add entry vestibules	SIR's are all less than 1.
E1.6	1111, 1150	Add attic insulation	SIR is less than 1.
E1.8	4188	Extend existing EMCS to serve these additional buildings	SIR is less than 1.

TAB NO. IN STUDY	BUILDINGS FOR WHICH ECO IS NOT RECOMMENDED	ECO DESCRIPTION	REASON FOR REJECTION
E1.9	P-6201, P-6202, P-6203, P-6204, P-6215	Insulate domestic hot water tanks	Under construction or does not apply
E1.10	P-6201, P-6202, P-6203 P-6204, P-6215	Reduce air infiltra- tion	Under construction or does not apply
E1.11	P-6201, P-6202, P-6203 P-6204	Add attic insulation	Under construction
E1.12	P-6201, P-6202, P-6203 P-6204	Add interior insulating windows	Under construction
	Ft. Sam Houston Basewide	Convert to more efficient street and area lighting. See individual lighting ECO descriptions below.	
E2.4		Replace 1500W incan- descent lighting at recreational areas with HPS	Simple payback is greater than 10 years.
E2.7		Replace 750W incan- descent area lighting throughout FSH.	Simple payback is greater than 10 years.
E2.8		Replace 750W incan- descent area lighting at 4200 bldgs.	SIR is less than one and simple payback is greater than 10 years.

TAB NO. IN STUDY	BUILDINGS FOR WHICH ECO IS NOT RECOMMENDED	ECO DESCRIPTION	REASON FOR REJECTION
E2.12		Replace 300W incandescent area lighting at park.	SIR is less than one and simple payback is greater than 10 years.
E2.14		Replace 150W incandescent area lighting at SARPMA buildings.	SIR is less than one simple payback is greater than 10 years.
E2.16		Replace 100W incandescent area lighting at park and recreational areas.	Lighting is decorative with low usage. There is no suitable replacement.
E2.20		Replace 500 quartz area lighting at Riding Stables.	SIR is less than one and the simple payback is greater than 10 years.
E2.21		Replace 300W quartz area lighting at SARPMA buildings.	SIR is less than one and the simple payback is greater than 10 years.
E2.22		Replace 300W quartz area lighting at Jadwin Road.	SIR is less than one and the simple payback is greater than 10 years.

TAB NO. IN STUDY	BUILDINGS FOR WHICH ECO IS NOT RECOMMENDED	ECO DESCRIPTION	REASON FOR REJECTION
E2.25		Retrofit 700W mercury vapor area lighting w/310W HPS.	ECO-L24, appendix E2.24 is recommended in lieu of this ECO.
E2.27		Relamp 400W mercury lamps with 360W HPS	ECOL-26, appendix E2.26 is recommended in lieu of this ECO.
E2.29		Replace 250W mercury vapor lamps with 215W HPS lamps, no ballast change.	SIR is less than one and the simple payback is greater than 10 years.
E.31		Replace 175W mercury vapor lamps with 150W HPS lamps, no ballast change.	SIR is less than one and the simple payback is greater than 10 years.
E2.32		Reduce footcandles in buildings 4196 and 4197 by installing Thrift/Mate lamps	Dropped from study per interim review comments.

Table ES-4
Recommended Projects and ECO's in order of descending SIR

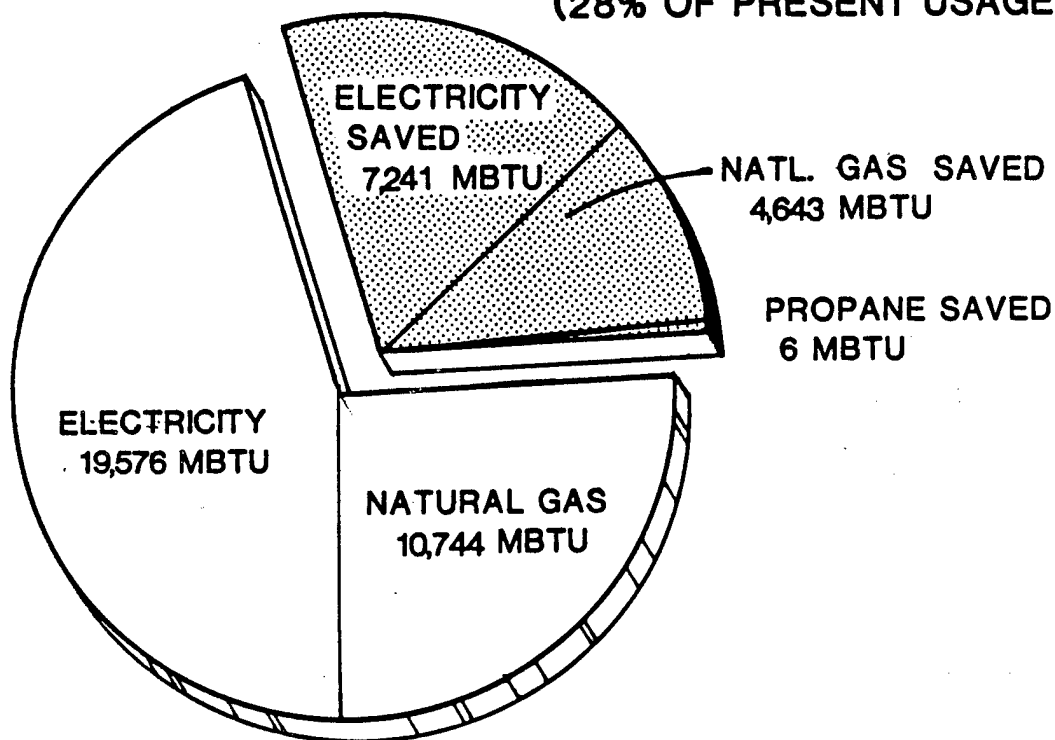
<u>PROJECT</u>	<u>TAB NO. OF ECO WITHIN PROJECT</u>	<u>CONSTRUCTION COST</u>	<u>SIR</u>	<u>SIMPLE PAYBACK (YEARS)</u>
Replace Inefficient Lighting (ECIP)				
	E2.17	\$1,1987	22.46	.53
	E2.15	\$13,370	9.79	1.23
	E2.1	\$40,992	9.71	1.32
	E2.3	\$18,093	8.63	1.48
	E2.10	\$2,746	7.93	1.56
	E2.2	\$30,417	5.76	2.23
	E2.26	\$44,331	5.54	2.42
	E2.6	\$14,987	4.92	2.58
	E2.23	\$25,955	4.69	2.86
	E2.5	\$17,952	4.51	2.81
	E2.13	\$36,149	3.62	3.34
	E2.11	\$7,547	3.50	3.54
	E2.9	\$3,334	3.49	3.61
	E2.19	\$30,494	2.83	4.53
	E2.24	\$5,837	2.32	5.76
	E2.28	\$4,318	2.26	5.97
	E2.18	\$11,045	1.90	6.50
	E2.30	\$60,415	1.43	9.58
	Total Project	\$369,969	4.92	2.6
Add occupancy Detector Controls for office lighting in bldgs 4196 and 4197. (OMA)				
	E.234	\$11,362	4.61	2.9
	Total Project	\$11,362	4.61	2.9
Reduce Footcandles in bldgs 4196 and 4197 by Removing Light Fixtures				
	E2.33	\$29,517	4.26	3.12
	Total Project	\$29,517	4.26	3.12
Add attic insulation (Camp Bullis)				
	E1.11	\$493	4.23	3.69
	Total Project	\$493	4.23	3.69

PROJECT	TAB NO. OF ECO WITHIN PROJECT	CONSTRUCTION COST	SIR	SIMPLE PAYBACK (YEARS)
	E1.11	\$493	4.23	3.69
	Total Project	\$493	4.23	3.69
Add ceiling fans to prevent air stratifi- cation				
	E1.7	\$92,186	3.16	6.68
	Total Project	\$92,186	3.16	6.68
Add attic insulation in 1100 and 1400 areas				
	E1.6	\$29,788	2.97	4.91
	Total Project	\$29,788	2.97	4.91
Window improvements in 1100 and 1400 areas				
	E1.4	\$109,215	1.90	7.77
	Total Project	\$109,215	1.90	7.77
Expansion of existing EMCS system to include the 4100 area				
	E1.8	\$111,408	1.62	6.17
	Total Project	\$111,408	1.62	6.17

ENERGY USAGE OF BUILDINGS & AREAS IN RECOMMENDED PROJECTS

TOTAL USAGE NOW
42,210 MBTU

TOTAL ENERGY SAVED
11,890 MBTU
(28% OF PRESENT USAGE)



TOTAL USAGE
AFTER IMPLEMENTATION
30,320 MBTU

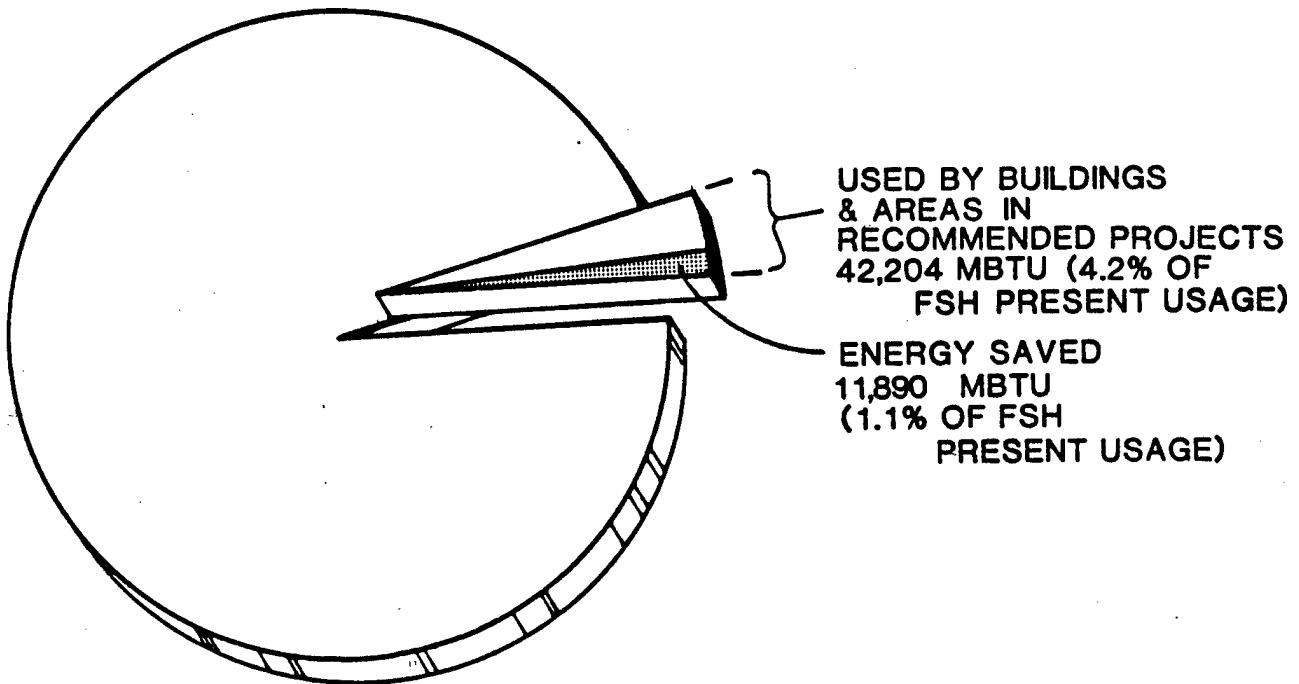
FULL CIRCLE: ESTIMATED ANNUAL ENERGY USAGE
BEFORE IMPLEMENTATION

SHADED: ESTIMATED ANNUAL ENERGY SAVINGS

UNSHADED: ESTIMATED ANNUAL ENERGY USAGE
AFTER IMPLEMENTATION

EFFECT OF RECOMMENDED PROJECTS ON TOTAL FT. SAM HOUSTON ENERGY USAGE

TOTAL ENERGY USED
NOW AT FSH
1,009,853 MBTU



FULL CIRCLE: TOTAL FSH ENERGY USAGE, FY 87

REMOVED SECTION: TOTAL ESTIMATED ANNUAL ENERGY USED
BY BUILDINGS AND AREAS IN
RECOMMENDED PROJECTS

SHADED SECTION: TOTAL ESTIMATED ANNUAL ENERGY SAVED